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Global Building Physics

Keynote Lecture

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ABSTRACT

High ambitions are set for the building physics performance of buildings today. No single technology can achieve fulfilment of these ambitions alone. Integrated, multi-facetted solutions and optimization are necessary. A holistic, or “global”, technological perspective is needed, which includes all aspects of the building as defined in building engineering.

We live in an international society and building solutions are developed across country borders. Building physics is a global theme. The International Association of Building Physics has global appeal.

The keynote lecture and this brief paper will illustrate some global relations and highlight some of the challenges we see today.

1. Introduction

The main theme of the 2012 conference has been declared as *Role of Building Physics in Resolving Carbon Reduction Challenge and Promoting Human Health in Buildings*. This paper and the keynote speech intend to respect this topic.

Buildings nowadays must be very energy efficient. At the same time we expect buildings to provide better indoor environments than ever, and we experience that the outdoor environment tends to have more extreme excursions. New buildings can possibly provide the shelter we need, but most countries have a substantial existing building stock, which was not built to be as efficient as can be achieved today, and which we cannot afford to, or perhaps even don't wish to, demolish within a short time span. On the contrary, we should see to it that buildings are as durable as possible, since they represent a significant investment of resources that should be cherished.

Buildings can also be seen as architectural pieces of art, but the shape and choice of materials are not always chosen optimally to meet the challenging indoor and outdoor environments.

Some advanced buildings suffer from inadequate indoor environments. They may be too cold in winter and too warm in summer, and the atmospheric climate is not always as optimal as it should be. Despite many years of research and dissemination to practitioners, building owners and users, many buildings still suffer from high humidity and possibly have mould problems.

Inherently, the problem is that buildings nowadays cannot be optimized for only one parameter at a time. Hygrothermal processes in buildings are mutually dependent, so an optimization needs to be carried out in an integrated (“global”) way.

But we also live in a global community. Building products are traded over country borders, targets and rating systems for sustainability of the built environment are set

internationally, and even consultancy services are nowadays offered across country borders. And we live, work and travel much more all over the world than in the past.

Above all of this setting, building physics is a universal discipline. As building physicists, we have an obligation to exercise our skills in such a way that the multi-facetted ambitions we have of our buildings can be fulfilled.

2. Challenges for buildings today

The paper and keynote lecture will list a number of challenges we see today, and it will highlight how building physics is a key discipline to alleviate the situation.

2.1 Energy and CO₂

Buildings must be very energy efficient. Nowadays we can make buildings which are zero or near-zero energy buildings. To achieve this, it is not sufficient to only add more thermal insulation to buildings, or to make them airtight. That will at least still be necessary, but in heating climates we have learned to consider the overall energy balance of buildings and not only minimize the heat losses but also considering the heat gains. Buildings nowadays can have a positive energy balance - at least for some parts of the time.

Buildings in cooling climates have their challenges too. Building physics is a key discipline to develop as passive strategies as possible to keep amenable climates in buildings. Shading, ventilation and latent cooling, e.g. from green roofs, may be among the obvious themes.

Many countries are nowadays actively setting tighter requirements for permissible energy consumption of buildings or for minimizing the release of green house gases. By 2007 the European Union expressed its 20-20-20 plan (EU, 2007), stating that by 2020, there should be a reduction of 20% of the emission of green house gases, renewable energy supply systems should have a 20% share, and there should be a 20% improvement of energy efficiency in general. In its 2010 recast of the Energy Performance of

Buildings Directive, EPBD (EU, 2010), it is stated that by 2020 all new buildings should be nearly zero energy buildings - a requirement which should be fulfilled already in 2018 for public buildings.

According to the European Union's roadmap for moving to a low-carbon community by 2050, the society's CO₂ emissions should be reduced to 20% of the 1990 level within the next 38 years (EU, 2012). The Danish government has the ambition that by 2035, all heating and electricity production, i.e. the energy supply sectors which are relevant for buildings, should be based fully on renewable energy sources (Government of Denmark, 2011).

As an example, the Danish Building regulation, in its 2010 edition has set targets for permissible energy consumption in buildings by the years 2015 and 2020. These levels are set as building classes which the building industry can use already today as benchmarks for advanced buildings. For residential buildings the 2015 level for energy frame will be around 37 kWh/(m²·yr), while the energy frame for 2020 will be 20 kWh/(m²·yr). These numbers include energy for provision of domestic hot water. The energy frame comprises primary energy demands for heating, cooling ventilation and domestic hot water. Particularly the 2020 level makes it clear that buildings need to be equipped with a system for energy production. Fig. 1 shows the development of the energy requirements for buildings in Denmark over the years.

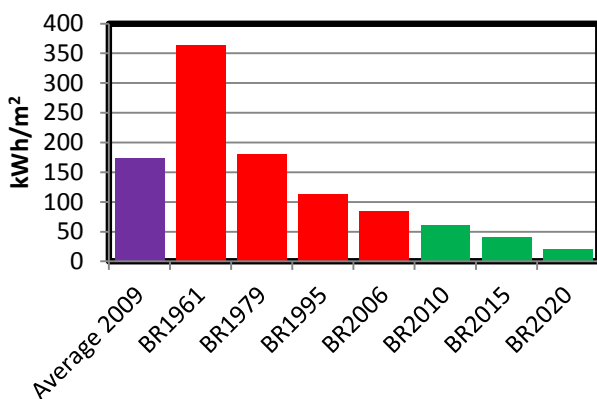


Fig. 1. Development of the permissible energy for conditioning of buildings in Denmark (1961-2020). The purple bar shows the average consumption for buildings in 2009.

Advanced buildings have gone from being low-energy buildings, over “passive houses” (Passivhaus Institut, 2012) and zero-energy buildings, to plus-energy buildings. The contemporary development is on grid-connected buildings which can be supplied with energy from renewable sources delivered in a community context. Smart control systems will be needed to manage how energy services are exchanged between suppliers and consumers of energy (Lynov et al., 2011).

Active houses are buildings which highlight not only the need for energy efficiency, but also give equal focus to the indoor climate and the environment in general. I.e. a holistic, or “global”, perspective is adopted (Active House, 2012).

A discussion in the context of energy is whether buildings should be still more energy efficient or if they should simply be energy producing. The answer is the “global one”: buildings will in the future have to be very energy efficient,

but also equipped with technologies for own or local renewable energy production. Some building physics expertise may need to be exercised when the exterior envelope of buildings is clad with energy supply systems such as photo voltaic panels or fixtures for small wind turbines and penetrations for heat pumps.

However, there will not be a perfect match between the availability and demand for energy services, and thus some forms of energy storage will be needed either at the community level, or at the level of each building.

As a sub-conclusion, it can be stated that building energy issues will remain among the classical building physics themes!

2.2 Stochastic assessment and why is it that the energy targets are not always met?

Traditionally in building physics analyses we have performed deterministic assessment. However, a hygrothermal analysis of, say, a whole building requires the input from a huge number of design variables each of which comes with its stochastic variation. Thus, the resulting outcome of the performance indices: e.g. energy consumption, indoor environmental quality and hygrothermal performance could vary enormously.

Apart from stochastic variation of physical properties of building products, the weather, etc., quite some variation comes from the influence of the behaviour of occupants. The difference between high and low energy consumption is often quoted to come to about a factor three among different occupants who live in similar buildings (Andersen, 2009). But according to the same author, the difference may come to even a factor of 20 or so (personal communication, findings to be published).

Obviously, workmanship can also exhibit huge differences, and it is well known that poor workmanship can be detrimental for a proper thermal performance of a building as well as for the moisture condition and durability of the building product. It can be very hard to quantify the variability of the effect of workmanship. Knowledge of building physics is therefore not limited to the design process alone, but good awareness should exist in the construction process and in the operation and maintenance of buildings.

For many of the reasons outlined above, it seems to have become commonplace that many new buildings do not meet their energy target. A factor two between the predicted and realized energy consumption may not be unusual for buildings which should be advanced and have very low energy consumption (e.g. Andersen, 2009 and Rode et al., 2011).

We need tools and methodologies to cope with this, so we can better represent the spread of the results, which is there in reality. This is currently the theme of the IEA ECBCS Annex 55 project, *Reliability of Energy Efficient Building Retrofitting - Probability Assessment of Performance & Cost (RAP-RETRO)* (IEA, 2012).

A practical consequence of the wide spread of the energy and other building physical performances of buildings should be to adopt programmes for quality assurance in all the phases: design, construction and operation of buildings. “Commissioning” is a systematic procedure for planning, documenting, scheduling, testing, adjusting, and verifying to

ensure that a building in operation comes to work in accordance with the design intent (Enck, 2010). This methodology is very important to ensure that the energy performance targets are met.

Likewise for moisture conditions of newly built buildings, the Swedish *ByggaF* procedure ensures that moisture issues are focussed upon and dealt with during the building process – something that has proven to be very beneficial (Mjörnell and Arfvidsson, 2008).

2.3 Air tightness and ventilation

For optimal energy efficiency and in order to avoid potential moisture problems, it is important that the building envelope is made and kept as air-tight as possible. However, it is equally important that buildings are equipped with other means of controlled supply of fresh air for the indoor environment. Such means shall either be in the form of natural ventilation through dedicated vent openings and with mechanical exhaust from rooms with release of moisture or pollutants, or it can be in the form of a mechanical ventilation system with dedicated supply and exhaust fans. Other combinations of ventilation principles are also possible, e.g. hybrid systems. With a balanced mechanical ventilation system it is possible to use a heat recovery unit, to recuperate a significant fraction of the energy otherwise lost with the exhaust air. The previous may seem trivial to mention, but anyway, it is very often a reason when buildings do not perform satisfactorily that the building envelope is either leaky, or the provision for ventilation is insufficient. And such problems are much too often seen in buildings today.

It should be acknowledged that heat recovery can be a challenge sometimes, e.g. in very cold climates, where there is risk of frost formation in the heat recovery unit (Rode et al., 2011). Some technical solutions exist, but there is still room for further development (Kragh et al., 2006). Energy recovery systems most likely also have a potential for further development and market introduction for buildings in cooling climates.

An interesting development is on development of heat recovery in combination with passive ventilation systems. These are developments which are still only on a prototype basis, but the potential is interesting if this principle can be used broadly (Hviid et al., 2011).

Proper air tightness and installation of ventilation systems can be a challenge in existing buildings, and we are still in need of better solutions for this sector. Meanwhile, it should be ensured that new buildings are constructed and equipped right with respect to air-tightness and ventilation. Air tightness can be ensured much better during the construction of a building, than afterwards, although it is not always a trivial task, and professional guidelines should be followed. Such guidelines for practitioners should exist on a national level, suitable for local craftsmen. For instance in Denmark exists a *Knowledge Centre for Energy Savings in Buildings* which issues such guidelines (Videncenter for energibesparelser, 2012a).

Blower door testing (some call it a “door fan” test) can be very instrumental in verification of the air tightness of a building. Given the importance of air tightness, one should regard the execution of such tests as a relatively simple precaution, and blower door tests, very often in combination

with infrared thermography to detect loci of leaks and thermal bridges, should be used more frequently than what is currently common practice in many countries.

The experiences shared through organizations such as the Air Infiltration and Ventilation Centre (AIVC, 2012) and TightVent (TightVent, 2012) are very important, and it is of particular importance to get this knowledge turned into practical use in the construction industry.

A standing issue still is how much to ventilate our buildings. First of all, ventilation must never be insufficient, but since ventilation is energy consuming, the amount of ventilation should be timely and not more than reasonably sufficient. Developments in demand controlled ventilation (Mortensen et al., 2011) and personal ventilation (Mazej, 2011) are interesting in this respect

2.4 Climate change

It is indisputable that climate change is occurring. It may be difficult to predict exactly which changes will occur, how soon they will come, and to get an idea of where it tends over a very long time scale. See Fig. 2 which is from one of the reports of the Intergovernmental Panel on Climate Change (IPCC, Solomon et al., 2007). The general sensation with climate change is that the climate tends towards more frequent occurrences of extreme weather with more intense precipitation, heat spells, cold spells and storms. These climatic excursions also influence the moisture conditions around buildings, e.g. with high water loads.

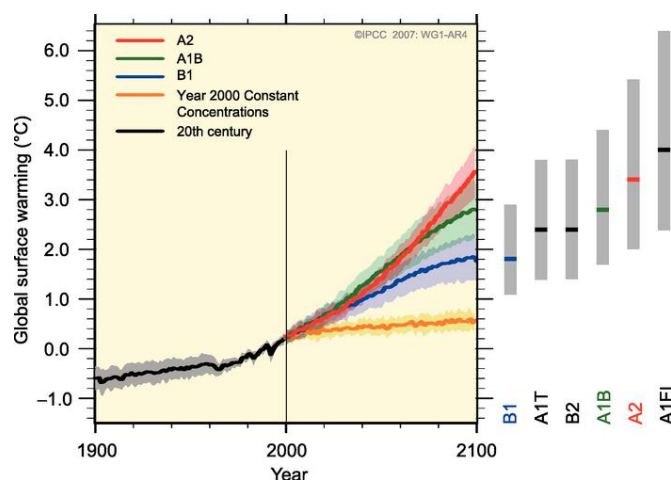


Fig. 2. Possible scenarios for development of global surface warming according to several of the IPCC's climate change scenarios.

Buildings can be significantly affected by the new outdoor climatic loads, and it is an important task for building physicists to analyse these influences. The task has relevance both in relation to how we should best protect our existing buildings, and in relation to how new buildings should be designed, constructed and operated such that they can endure the climatic loads they will experience in their lifetime – which may be 100 years or more. The research is about how the building envelope and the indoor environment can best adapt to climate changes. We currently see a number of research projects where climatic change effects on existing buildings are analyzed, e.g. for heritage buildings (Sabbioni et al., 2006), and for public community buildings (Cox, 2011).

Other relevant research where we as building physicists deal with the climate change issue is on how we can mitigate the problem. We are among the scientific communities who can contribute most to making buildings carbon neutral, and we should certainly be aware of our responsibility in this context. In developed countries, like in Europe, buildings contribute by around 36% to the societies' emission of green house gases (BPIE, 2011). Our research into techniques for passive operation of buildings and utilization of renewable energy sources can offer significant contributions to reducing the sector's share of CO₂ emissions.

2.5 Building renovation

The rate of constructing new buildings in developed countries is around 1% per year (BPIE, 2011). New buildings do not always replace existing buildings but come as a supplement to the existing building stock. Since existing buildings most often are less energy efficient than new buildings, it is necessary to find ways to significantly enhance the energy performance of the existing building stock and to stimulate the sector's change towards carbon neutral or very efficient energy supply systems. This will be necessary if the goals for a low carbon society by 2050 should be met.

Introduction of energy enhancements technologies into existing buildings incur significant technical challenges, including many that require very good management of building physics principles. Adding additional insulation, improving air-tightness, replacing windows, and installation of ventilation systems are all examples of energy refurbishment measures which are possible to make, but all should be made with care to make sure that the improvements will work well, and to make sure that no secondary problems will occur. Adding extra insulation on the warm side of walls, for instance, is known to be potentially problematic (Videncenter for Energibesparelser, 2012b). Some energy enhancement measures may also have aesthetical and practical implications which should be taken seriously in the "global" perspective.

When renovating existing buildings, it may always be considered if it would be a better choice to demolish the existing buildings and replace them with a new and energy efficient ones. Since nowadays certification systems for sustainability of buildings such as LEED, BREEAM and DGNB (see the reference list) are becoming commonplace in most countries, it is very important that these systems are also further developed to consider the value of the existing building stock in relation to building new. This is the theme of a PhD-project at the Technical University of Denmark (Eriksen, 2010-14).

2.6 Building envelope and materials

This is the classical theme of building physics. Despite of many years of past research, e.g. as published in Journal of Building Physics (2012), and its predecessors: Journal of Thermal Envelope and Building Science and Journal of Thermal Insulation, there is quite some research going on today to further improve the envelope of buildings, and the materials it comprises. Subthemes and recent areas of development can be summarized as follows (the list does not pretend to be exhaustive):

- *Thermal insulation.* New insulation types such as vacuum insulation, aerogels, graphite doped products,

and various composites are developed and slowly entering into the market. These products have significantly better (lower) thermal conductivities than many other products that currently dominate the market.

- *Windows.* Also windows are today being further improved. Windows with frames made of fibre reinforced composites have warmer edges than traditional windows. Heat mirror window panes may be developed with enhanced durability and very low U-values.
- *Thermal bridges.* With lower heat transmission through the plane surfaces of the building envelope, there is an ever increasing relevance of minimizing the thermal bridges of buildings, e.g. at foundations, at window joints, etc.
- *Thermal mass and Phase Change Materials (PCM).* Adding thermal mass to buildings may reduce the energy consumption by perhaps some 10% when comparing a heavy-weight to a light-weight building, and the risk of very high indoor temperatures in summer may be reduced (but also a risk that the temperatures do not come down to comfortable levels during night). Use of phase change materials is a way to superficially enhance the thermal capacity of buildings at a certain desired temperature, which may be beneficial. The use of PCM is still somewhat limited, and it remains to be proven that the benefit is worth the investment compared to using other means to enhance the thermal capacity of buildings.
- *Attics and crawl spaces.* These rooms have, at least in some countries, a reputation of being laden with moisture problems. True is it that in some periods of the year, and depending on the conditions for ventilation, these constructions can be problematic. Long-wave radiation to the sky (for roofs) and quality of workmanship to prevent unintended passage of humid air from inhabited rooms also affect the situation. Further experience and smart ways to control the need for air-exchange (e.g. Hagentoft et al., 2008) may alleviate the situation in such rooms.
- *Shading systems.* Due to enhanced thermal insulation value of building components, and due to some building designers' affection for glazed facades, and possibly also due to climate change effects, overheating problems becomes an increased curse on buildings. Shading systems, possibly with smart controls may be a good way to improve the thermal indoor environment. It can be combined with some daylight directing techniques to ensure that the indoor lighting conditions are suitable.
- *Durability (no moisture or mould problems).* With today's focus on sustainable construction, it is the belief of the author that durability of constructions, and healthy indoor environments which are free of undesired biological activity and free from release of harmful airborne compounds, will come more into focus (again) once we have learned to build and rebuild very energy efficient buildings. With demand-controlled minimal ventilation, the margin for errors is less, and we really need analytical tools and building automation systems which can help to avoid the occurrence of harmful processes in our buildings.

2.7 Interaction with building services

The building services area is another technical field (the HVAC sector), which is parallel to the field of building physics. However, there are so many mutual interactions, as it has even been indicated with some of the themes previously in the paper, that we once again have to see the situation through global, holistic glasses. There are so tight links between building physics themes, how buildings are Heated, Ventilated and Air-Conditioned (HVAC), and how the systems are operated and controlled, that we need continuous mutual development of our skills. Without further elaboration, the following (non-exhaustive) list highlights some of the themes which are of mutual interest.

- Low temperature heating/high temperature cooling – thermo-active building systems
- Shading and passive cooling techniques
- Lighting and daylight
- Ventilation
- Energy supply systems, incl. heat pumps
- Domestic hot water
- Integrated solutions

2.8 Smart buildings and grid-connected buildings

For optimal and energy efficient operation of buildings in the future, it will be obvious to harvest from the possibilities made available through increased use of information technology. We know nowadays, as we have learned from our mobile phones, how these technologies can be made in such a way that most users can interact rather freely and easily with the technology. “Smart” technologies should make it possible that our buildings are conditioned to our liking when we need it, and that they can run as passively as possible at other times. Scheduling, forecasting, and measuring on many building physics parameters will be important in this context. Much forecasting could be model based, and again, building physics experts will be important in such developments. However, we must be open-minded and cooperate well with completely other experts, e.g. also from human sciences, in order to reach the most optimal results for people (here is the “global” perspective again).

In addition, we must understand that buildings are not islands. Buildings are very often located in cities, and the way buildings are operated, how they consume resources which must be supplied, and also how buildings nowadays can deliver resources to the neighbourhood, become crucial aspects for the optimal total performance of buildings and the communities in which they belong. For instance, it is very nice that buildings can produce some of their own energy, but they should also be able to deliver it to the community, when they cannot use it themselves. Furthermore, energy and other resources should be produced where it is most rational, and that may in some cases be outside of the plot of each building – possibly in central production plants in the vicinity of the city. Grid connection and smart control and distribution of the resources will be essential. From the buildings’ perspective, our building physics models and analyses are important to express the demands the buildings have from the community, and to forecast what they can deliver.

Finally, it should be mentioned that information technology and measuring systems, when integrated into our buildings can help us to control our indoor environments and the well-being of our building structures in the best way. Soon it will be commonplace to have the possibility to be alerted from

our buildings, not only in cases of fire or burglary, but also when the indoor environment needs some adjustment, or when a moisture problem is arising. It is important, however, that the adaptation of these technological adventures is co-driven by the users.

2.9 Conclusion: Building physics is needed

As a conclusion from all of the above, it should appear obvious that building physics will remain a very important discipline. It should appear obvious also that we need to cooperate well with experts from adjacent technological areas, but also with experts from completely different fields.

We must never stop further development of our research and become even more skilled in our own scientific sphere, as long as we remember to have a well-developed outreach to other fields (and them to us). However, an important point is that we also have a very open outreach to the practitioners, to end-users and that we communicate well with policy makers. Particularly, we should be generous to offer our skills to companies with whom we can cooperate to make new products and develop new solutions.

In order to succeed making very energy efficient and fail-proof buildings with good indoor environments, we need more innovation in the building industry. As researchers in building physics, we have an obligation to cooperate with industry and stakeholders on enhancing the knowledgebase and stimulate an innovative culture in the building sector.

Finally, and not least, we must be good educators and not hesitate to disseminate our expertise to a wide variety of recipients: from graduate students, over colleagues in the building industry to end-users. And we should remember that good dissemination is a two-way process: we must listen to our recipients and further develop good working relations with them!

3. International cooperation

3.1 Being global

Building physics needs to be exercised based on local conditions. Climate is local, user habits are local, building culture (architecture) is local, and building traditions, e.g. choice of materials, are local, and regulations are local. It is very important for the successful implementation of building solutions that this is respected.

Despite of this, physics is universal, building products increasingly come from the global market, and our whole culture is becoming more international. As building physics community we do rather well to exchange information and experiences among ourselves. However, compared to other research fields, we are not very many experts. We more or less know our colleagues all over the globe.

Building physics has relevance in all climates. The challenges are global. While building physics has evolved predominantly from countries with cold climates, there is potential and good reason to let our theme flourish also to other regions of the world, where building physics has so far not been so visible. Let us encourage all building physicists to spread awareness about our profession to collaborators in new regions.

Climatically, we learn a lot from how our theme is exercised also under extreme conditions. Building physics activity

under Arctic and near-Arctic conditions is well under way (Kotol, 2012), and cooperation is being developed between partners in Greenland, Canada, Alaska, the cold north-eastern parts of China, and the Nordic countries (Artek, 2012). One could foresee that more cooperation with countries from low-latitude, warm climates will also be developed in the time ahead.

These years, most economic growth happens in the so-called BRIC-countries (Brazil, Russia, India and China). This development is reflected in the building industry with a lot of construction activity – at least in some of these countries. It is of utmost importance that this activity is carried out in such a way that the building solutions are as sustainable as possible. Since buildings are products which will (hopefully) last for many years, it makes a lot of sense to cater for a good and energy efficient performance from the beginning. The building physics community should help to develop sustainable and locally adopted solutions together with colleagues in the fast developing countries.

A good way to disseminate skills and information about our research theme is through educational activity. Since university degree education is very international, it is important that building physics is represented in the curricula for graduate education at our educational institutions. Where possible, a strong building physics curriculum should be integrated with related topics in building engineering programs. Cooperation on PhD summer schools is another way we can mutually disseminate research based knowledge and stimulate development of new knowledge. The fundamental knowledge in our fields can very well be developed internationally, so it makes a lot of sense to cooperate on research schools, and such activity should be stimulated.

3.2 What IABP does

IABP is the International Association of Building Physics.

IABP is the organization which fosters academic sponsorship of the triennial International Building Physics Conference. Members of IABP are the participants of the conferences. However, the IABP is an organization without financial power. The activity of the organization is based on voluntary work, and the organization cannot financially support the conferences. We are very happy therefore that academic institutions have so far safeguarded the continued arrangement of the conferences. The IABP is very much indebted to the previous hosts: TU Eindhoven (the Netherlands, 2000), KU Leuven (Belgium, 2003), Concordia University (Canada, 2006) and Istanbul Technical University (Turkey, 2009) for hosting the previous conferences. This year we convene at Kyoto University, Japan, and our sincere gratitude goes to our hosts in a country which has endured so much natural and infrastructural disaster after the 2011 earthquake and tsunami!

The IBPC Conferences go in sync with two other triennial events:

- The *Thermal Performance of the Exterior Envelopes of Whole Buildings Conferences*. The conferences are mostly held in Florida, and in the beginning of December. The conferences are arranged by Oak Ridge National Laboratory among others (ORNL, 2012).
- The *Nordic Symposia of Building Physics*. Though started in and always being hosted in a Nordic Country,

the symposia have gained in international participation and now have over half of the participants from other than the Nordic countries who come to enjoy building physics science in the light Nordic summer-nights. The ninth Symposium was hosted by Tampere University, Finland (NSB, 2011) as an IABP endorsed event. The next one will be in 2014, and will be hosted by Lund University.

The IABP also offers academic sponsorship of the Journal of Building Physics. Although this is not the only journal in which we can publish our research findings, this is certainly the one that thematically centres the most around the same themes as the IABP. The journal is issued four times per year, and the publisher just increased the number of pages to 112 per issue, which renders room for some 5 to 6 papers per issue. On-line papers are printed 5-6 weeks after acceptance, and as of fall 2012 the Journal will have a web page to which authors can submit papers directly. The journal is indexed by Thomson Reuters, and thus the articles receive the attractable ISI predicate for being listed in that company's science citation index.

As a new intended activity it would be desirable if we could use the IABP as an organization to help coordinate and stimulate arrangement of international summer schools for PhD-students in our field of research. Lending from previous summer courses on heat and mass transport in buildings arranged by ETH (2009, Zürich, Switzerland – see ETH, 2009), DTU (2008, Copenhagen, Denmark, see DTU, 2008), and previous events at KU Leuven (Belgium) and Concordia University (Montreal, Canada) it is intended to continue with similar schools. This summer, 2012, such a school will be hosted by TU Vienna (Austria), coordinated by Prof. Thomas Bednar (TUW, 2012). The summer school will take place as a two week activity in the beginning of July. The idea is that the first week will bring the participants to the same level of “advanced basic knowledge” of building physics concepts. The second week will be spent of a contemporary research topic, which this year has been chosen to be *Probability Assessment of Building and Construction Performance*. Some 25 PhD students are anticipated to participate. The intention is that this activity can be continued possibly every year from now on, and future hosts are being considered.

Finally it can be informed that the domain www.internationalbuildingphysics.org has been reserved for the IABP, and the organization should see to it that this Internet site will be well maintained to represent the activities outline above.

4. References

All web-links are verified on May 18, 2012.

- Active House. 2012. Active house alliance. <http://www.activehouse.info/about-active-house>
- AIVC, Air Infiltration and Ventilation Centre. 2012. www.aivc.org
- Andersen, R.V. 2009. Occupant Behaviour with Regard to Control of the Indoor Environment. Ph.D. Thesis, International Centre for Indoor Environment and Energy, Department of Civil Engineering, Technical University of Denmark.
- ARTEK. 2012. Artek Event 2012. Arctic Technology Centre. <http://www.artek.byg.dtu.dk/English/ARTEK%20Events.aspx>

- BPIE. 2011. Europe's buildings under the microscope - A country-by-country review of the energy performance of buildings. Building Performance Institute Europe. www.bpie.eu.
- BREEAM. 2012. BRE Environmental Assessment Method. BRE (Building Research Establishment) Group. <http://www.breeam.org/>
- Cox, R. 2011. Climate Change and its Impact on Lifetime and Maintenance of Buildings. PhD-project (2011-2014). Department of Civil Engineering, Technical University of Denmark.
- DGNB. 2012. Deutsche Gesellschaft für Nachhaltiges Bauen (German for: German Society for Sustainable Building). <http://www.dgnb.de/en/>
- DTU. 2008. PhD summer course on Heat and Mass Transport in Building Materials, Components and Whole Buildings: From Fundamentals to New Advances. Technical University of Denmark. <http://indico.conferences.dtu.dk/conferenceDisplay.py?confId=17>
- Enck, H. J. 2010. Commissioning High Performance Buildings. In: ASHRAE Journal, American Society of Heating, Refrigerating and Air-Conditioning Engineers. January 2010.
- Eriksen, M.S.H. 2011. Bæredygtighed ved renovering af eksisterende byggeri (Danish for: Sustainability in renovation of existing buildings). PhD-project (2011-2014). Department of Civil Engineering, Technical University of Denmark.
- ETH. 2009. Summer course on Heat and Mass Transport in Building and Urban Physics. Swiss Federal Institute of Technology. <http://www.carmeliet.arch.ethz.ch/Events/Summercourse09>
- EU. 2006. Action plan for Energy Efficiency: Realising the potential. Commission of the European Communities.
- EU. 2010. Directive on the Energy Performance of Buildings (recast). The European Parliament.
- EU. 2012. Roadmap for moving to a low-carbon economy in 2050. European Commission. http://ec.europa.eu/clima/policies/roadmap/index_en.htm.
- Government of Denmark. 2011. Vores Energy (Danish for: Our Energy). The Danish Government's plan of action for a transition towards a low carbon society. http://www.ens.dk/Documents/Netboghandel%20-%20publikationer/2011/vores_energi.pdf
- Hagentoft, C.-E., Sasic Kalaasidis, A., Nilsson, S.F. and Thorin, M. 2008. Mould growth control in cold attics through adaptive ventilation. In: Proceedings of the 8th Symposium on Building Physics in the Nordic Countries. (C. Rode, editor), Report R-189, Dept. of Civil Engineering, Technical University of Denmark, Kgs. Lyngby, Denmark.
- Hviid, C. and Svendsen, S. 2011. Analytical and experimental analysis of a low-pressure heat exchanger suitable for passive ventilation. In: Energy and Buildings, 43 (2-3), pp. 275-284. 2011.
- IEA. 2012. International Energy Agency, Energy Conservation in Buildings and Community Systems Programme (ECBCS), Annex 55, Reliability of Energy Efficient Building Retrofitting - Probability Assessment of Performance & Cost (RAP-RETRO). <http://www.ecbcs.org/annexes/annex55.htm>
- Journal of Building Physics. 2012. <http://jen.sagepub.com/>
- Kotol, M. 2012. Survey of occupant behaviour, energy use and indoor air quality in Greenlandic dwellings. In: Proceedings of the 5th International Building Physics Conference, Kyoto.
- Kragh, J. Rose, J. and Svendsen, S. 2006. Bæredygtigt arktisk byggeri i det 21. århundrede. Energirigtige ventilationssystemer. (Danish for: Sustainable Arctic buildings for the 21st century – energy efficient ventilation systems). Department of Civil Engineering, Technical University of Denmark. Report SR 06-08. <http://www.byg.dtu.dk/upload/institutter/byg/publications/rapporter/byg-sr0608.pdf>
- LEED. 2011. Leadership in Energy and Environmental Design. U.S. Green Building Council. <http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1988>
- Lynov, J.-P., Holm, D.O.C., Andersen, M.-M., Rode, C. and Olesen, B.W., Buildings for smart cities. In: Risø energy report 10 : Energy for smart cities in an urbanised world. Technical University of Denmark. <http://orbit.dtu.dk/services/downloadRegister/6296427/ris-r-1778.pdf>
- Mazej, M. 2011. Investigation in the Characteristics of the Personal Ventilation using Computational Fluid Dynamics. In: Indoor and Built Environment.
- Mjörnell, C. and Arfvidsson, J., 2008. ByggaF A Method for Including Moisture Safety in the Building Process – Experience from Pilot Projects. In: Proceedings of the 8th Symposium on Building Physics in the Nordic Countries (C. Rode, editor), Report R-189, Dept. of Civil Engineering, Technical University of Denmark, Kgs. Lyngby, Denmark.
- Mortensen, D.K., Walker, I., Sherman, M. 2011. Optimization of Occupancy Based Demand Controlled Ventilation in Residences. In: International Journal of Ventilation. 10 (1), pp. 49-60. 2011.
- NSB. 2011. Nordic Symposium on Building Physics. <http://webhotel2.tut.fi/nsb2011/>
- ORNL 2012. Thermal Performance of the Exterior Envelopes of Whole Buildings XII International Conference. <http://www.ornl.gov/sci/buildings/2012/>
- Passivhaus Institut. 2012. About Passive Houses – What is a passive House? http://www.passiv.de/en/02_informations/01_whatisapassivehouse/01_whatisapassivehouse.htm
- Rode, C.; Vladyková, P.; Kotol, M.. 2011. A Low-energy Building under Arctic Conditions - Experiences after Five Years of Operation. In: Proceedings of the 9th Nordic Symposium on Building Physic. Vol. 3. Tampere University of Technology, 2011. pp. 1365-1372.
- Sabbioni, C. et al. 2006. Global climate change impact on built heritage and cultural landscapes – NOAHS ARK. EC project, 6th Framework Programme on Research. http://noahsark.isac.cnr.it/publications/Publication_3.pdf
- Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.). 2007. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 2007. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. http://www.ipcc.ch/publications_and_data/ar4/wg1/en/contents.html
- TightVent. 2012. TightVent Europe an organization initiated by INIVE EEIG - International Network for Information on Ventilation and Energy Performance. www.tigtvent.eu.
- TUW. 2012. International Association of Building Physics - Summer School. Arranged by TU Vienna. <http://www.bph.tuwien.ac.at/>
- Videncenter for Energibesparelser (The Danish Knowledge Centre for Energy Savings in Buildings). 2012a. Tætning af klimaskærm i forbindelse med energirenovering (Danish for: Sealing the building envelope for energy renovation)

http://www.byggeriogenergi.dk/root/media/38279_t%20E6tning%20af%20klimask%20E6rm.pdf

Videncenter for Energibesparelser (The Danish Knowledge Centre for Energy Savings in Buildings). 2012b. Indvendig efterisolering af tung ydervæg (Danish for: Interior insulation of heavy-weight outer wall)
http://www.byggeriogenergi.dk/root/media/42366_Indvendig%20efterisolering%20af%20tung%20yderv%20E6g_OK.pdf